Joint Comments of the Washington State University Cooperative Extension Energy Program and the Washington State Department of Community, Trade and Economic Development on the Proposed Rule regarding Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures, Labeling and Certification Requirements for Electric Motors Docket No. EE-RM-96-400

by
Johnny Douglass, P.E.
Washington State University Cooperative Extension Energy Program

and
Elizabeth Klumpp
Washington State Department of Community, Trade & Economic Development

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## I. Introduction

The Washington Department of Community, Trade and Economic Development (CTED) works extensively with communities, businesses and power utilities within the state to support a healthy state economy. One of CTED's roles is to ensure that energy is used efficiently and is acquired through lowest total cost approaches. One of the most cost-effective approaches to ensuring that energy is used efficiently by end-users in the state is to have the federal government establish cost-effective energy efficiency standards at the national level that effect the manufacture of products across the country.

The Washington State University Cooperative Extension Energy Program performs research in the field of energy efficiency and provides technical leadership and support in the development of energy efficient processes and technologies. Collectively, staff in Washington State have years of experience working with the motor industry including manufacturers, repair shops, distributors and end-users. This experience includes developing energy efficient motor repair guidelines to developing an analytical and database tool, MotorMaster. Motor efficiency engineers at the Washington State University's Energy Program and energy policy staff at CTED staff have reviewed the Department of Energy's (Department) proposed rule for electric motors. Together, we clearly support the Department's proposed rule. This new rule is several years past due and we encourage the Department to delay no longer and to implement this proposed rule.

We have included some comments either in specific support of the Department's rule or as recommendations for modifying the existing test procedures and labeling programs to increase clarity and ensure compliance with the intent of the Department's rule.

## II. Technical Modifications to Proposed Rule

### A. Voltage rating

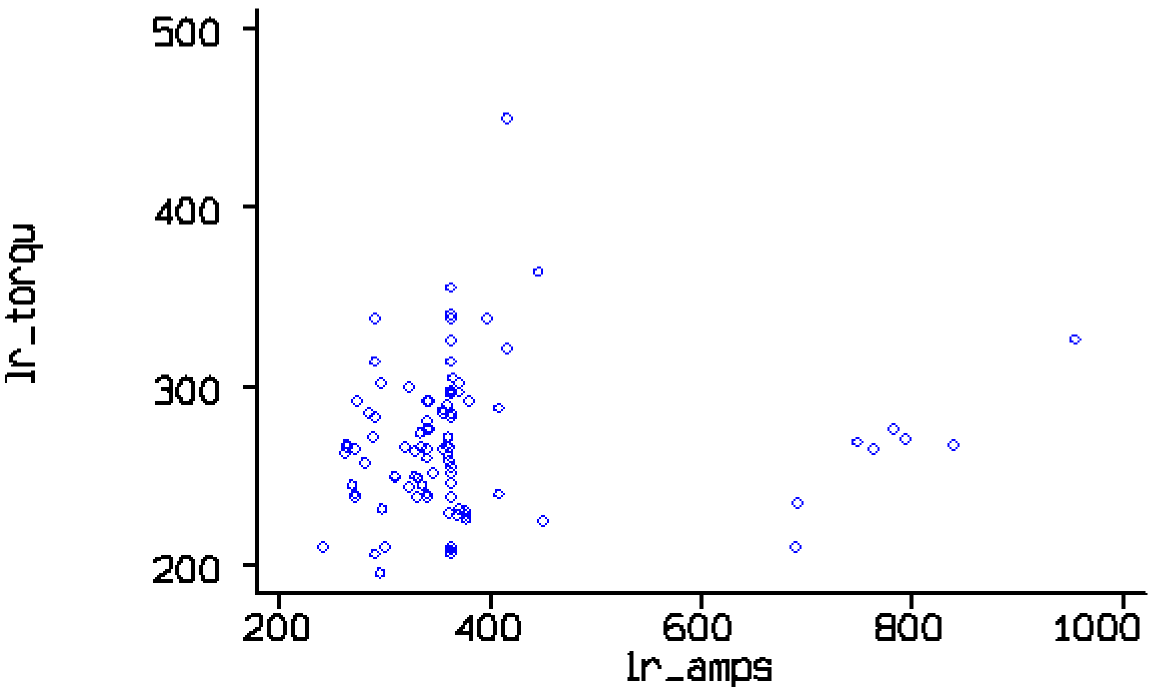
Definition of voltage rating is discussed on page 60442 and appears in the rules on page 60465. The rules specify that a covered electric motor is one rated at 230 and/or 460 volts. These are motors designed for standard service voltages or 240 and 480 volts. Motors are rated from 0 to 8% lower to allow for presumed distribution system voltage drop. A tolerance should be placed on the 230/460 volt stipulation to allow for slight deviations that occur in this rating among motor models intended for the same service voltage. For example, Grainger rates some of its motor models at 220 and 440 volts. We have encountered one imported motor rated at 480 volts. At least a 10% tolerance applied to the 230 and 460 volts should cover this. It appears to be covered in item (7-ii) of Sec. 431.2, Definitions, but we recommend it be made more explicit as follows: "(ii) Can be operated on 230 volts or 460 volts without exceeding the 10% over/under voltage tolerance stipulated in National Electrical Manufacturers Association (NEMA) MG1 1993 R1, section 12.44."

### B. Definite purpose

We strongly support the language, "...cannot be used in most general purpose applications" in the definition of "definite purpose motor" advocated on page 60444. Many motors are currently labeled as pertaining to a certain use such as "compressor", "fan and Blower", even "fish processing" duty or "farm" duty when they could easily serve any general purpose application. This practice could expand into a significant loophole, for inappropriate designation as definite purpose, were it not for the clarifying language.

### C. International Electrotechnical Commission (IEC) motor accelerating torque

On page 60442 it is concluded that IEC motors will not be suitable for machinery requiring a high torque start because they are presumed to accelerate more slowly [presumably due to lower starting torque]. This alleged relationship may not be that significant. Data in MotorMaster indicate little correlation between starting current and starting torque within a given motor class. See the graph below:




D. Classification of IEC motors

IEC motor shaft output power is rated in kW increments which do not exactly coincide with NEMA standard horsepower ratings. To accommodate this the Department proposes that IEC motors with ratings falling between two standard horsepower ratings should be required to meet the more stringent rating of the higher horsepower. While reasonable in principal, this could be unduly prejudicial against some IEC motors. Seven IEC standard kW ratings are coincidentally higher than their nearest horsepower equivalents by less than 1% which would force them to jump up to the next horsepower increment which can be 20 to 50% higher. We recommend that the rules allow the IEC motor to test down if it is rated within 1% of a lower horsepower increment. This appears to have been done in Sec. 431.42 (a) although it is not clearly explained in the preceding supporting material.

E. Basic model definition

Since there are many thousands of motor models, the proposed rules on page 60465 would allow consolidating models from a single manufacturer "which have the same rating, and electrical characteristics that are essentially identical, and do not have any differing physical or functional characteristics which affect energy consumption or efficiency." This is a very reasonable idea, but the limits on what can be consolidated may need to be more specific. Already, manufacturers tend to change materials sources and assembly techniques, even within a given model, with no indication on the nameplate nor retesting to verify efficiency. The department specifically asks, "What constitutes a difference between 'basic models'?" We suggest additional clarifying language stipulating that all electric motors (not models) consolidated into a basic model must have the following:

- identical enclosure designation,
- identical and interchangeable stator cores,
- electrically identical windings, i.e. circular mils and amp-turns per slot, winding pattern, and resistance in milliohms per rated volt (This could allow both 230 and 460 volt models within a single basic model.), and
- identical and interchangeable rotor core and cage.

We recommend that no untested model be adopted into a basic model consolidation if it has mechanical features that tend to increase friction or windage above tested models. Examples of such features include but are not be limited to those listed:

- larger bearings,
- sealed versus shielded bearings,
- larger or higher capacity cooing fan, or
- shaft grounding brushes.

F. Minimum efficiency not equal to 20% greater losses.

Page 60488 cites the popular myth that the relationship between NEMA nominal efficiency and NEMA minimum efficiency is based upon the latter having 20% greater losses. In fact, this loss amount is quite variable, ranging from a high of 25% to a low of 9%. See the table below which is NEMA MG-1 Table 12-8 with a column added representing the real percent difference in losses between nominal and minimum. We support the Department's decision to not include references to minimum efficiency in the rules or on the labels.

| | nom | min | pct greater losses in min |
|---|---|---|---|
| 1. | 99 | 98.8 | 20 |
| 2. | 98.9 | 98.7 | 18 |
| 3. | 98.8 | 98.6 | 17 |
| 4. | 98.7 | 98.5 | 15 |
| 5. | 98.6 | 98.4 | 14 |
| 6. | 98.5 | 98.2 | 20 |
| 7. | 98.4 | 98 | 25 |
| 8. | 98.2 | 97.8 | 22 |
| 9. | 98 | 97.6 | 20 |
| 10. | 97.8 | 97.4 | 18 |
| 11. | 97.6 | 97.1 | 21 |
| 12. | 97.4 | 96.8 | 23 |
| 13. | 97.1 | 96.5 | 21 |
| 14. | 96.8 | 96.2 | 19 |
| 15. | 96.5 | 95.8 | 20 |
| 16. | 96.2 | 95.4 | 21 |

| | | | |
|---|---|---|---|
| 17. | 95.8 | 95 | 19 |
| 18. | 95.4 | 94.5 | 20 |
| 19. | 95 | 94.1 | 18 |
| 20. | 94.5 | 93.6 | 16 |
| 21. | 94.1 | 93 | 19 |
| 22. | 93.6 | 92.4 | 19 |
| 23. | 93 | 91.7 | 19 |
| 24. | 92.4 | 91 | 18 |
| 25. | 91.7 | 90.2 | 18 |
| 26. | 91 | 89.5 | 17 |
| 27. | 90.2 | 88.5 | 17 |
| 28. | 89.5 | 87.5 | 19 |
| 29. | 88.5 | 86.5 | 17 |
| 30. | 87.5 | 85.5 | 16 |
| 31. | 86.5 | 84 | 19 |
| 32. | 85.5 | 82.5 | 21 |
| 33. | 84 | 81.5 | 16 |
| 34. | 82.5 | 80 | 14 |
| 35. | 81.5 | 78.5 | 16 |
| 36. | 80 | 77 | 15 |
| 37. | 78.5 | 75.5 | 14 |
| 38. | 77 | 74 | 13 |
| 39. | 75.5 | 72 | 14 |
| 40. | 74 | 70 | 15 |
| 41. | 72 | 68 | 14 |
| 42. | 70 | 66 | 13 |
| 43. | 68 | 64 | 13 |
| 44. | 66 | 62 | 12 |
| 45. | 64 | 59.5 | 13 |
| 46. | 62 | 57.5 | 12 |
| 47. | 59.5 | 55 | 11 |
| 48. | 57.5 | 52.5 | 12 |
| 49. | 55 | 50.5 | 10 |
| 50. | 52.5 | 48 | 9 |
| 51. | 50.5 | 46 | 9 |

G. Labeling minimum efficiency

Minimum efficiency is discussed on page 60452. The Department appears not inclined to include minimum efficiency on the motor nameplate or any certification documentation. We likewise recommend against labeling motors with minimum efficiency. It is a confusing term with little basis in reality. It implies that the real population of motors follows somewhat of a truncated Gaussian distribution with the peak at the mean efficiency and nothing below minimum efficiency. Our review of actual motor efficiency from motor testing laboratories shows real distributions to be far less idealized. There are no sharp delineations at the minimum efficiency level. Many individual motors fall below the nominal and significant numbers below the minimum. There is popular belief that the minimum efficiency is a "guaranteed" minimum. However customers have no practical way of determining if the minimum is exceeded so it would be a meaningless guarantee. We believe that rigorous verification of compliance with the nominal efficiency will greatly reduce the occurrences of motors below minimum.

H. Alternative efficiency determination method

Some manufacturers have advocated for alternative efficiency determinations methods as discussed on page 60448. The Department proposes to permit manufacturers to determine efficiency through predictive mathematical calculations. We are not opposed to this but we advise extreme caution. Simplified predictive methods tend to operate by fortifying certain known quantities with assumptions about unknown ones. Motor designers routinely make trade-offs among loss categories in their designs. It is easy to design to a known test method by letting assumed (versus measured) loss categories run high.

I. Non traditional motor horsepower ratings

On page 60450 the Department expresses considerable concern about treatment of motors which may be manufactured with rated horsepower between two traditional ratings. We believe this concern may be largely moot. The traditional increments are close enough that demand for general purpose motors intermediate ratings between increments is unlikely. Indeed the only reason to expect a new intermediate rating like 12 hp would be if the department allows it to be rounded lower for test purposes. It should be remembered that unlike a combustion engine, the electric motor rating is not the maximum horsepower the motor will produce. It is a nominal output power at which nameplate and catalog performance parameters are tabulated. Most motors can operate near nameplate efficiency at loads down to 50% and can sustain operation in ideal conditions at power demand 15% higher than their rating. We recommend the same policy for intermediate horsepower ratings as recommended above for kW rated IEC motors. Motors exceeding an Energy Policy and Conservation Act (EPCA) standard output power rating by greater than 1% should test to the next higher ratings efficiency standard.

J. Labeling

Much discussion has been provided on the merits of mandatory labeling of complying motors. We believe a more important issue is deceptive labeling of non-complying motors. We believe a logo and official name must be carefully selected. "Energy efficient" is the official NEMA terminology for motors which meet their table 12-10 standard. That table is identical to EPCA for covered motors, but encompasses more motors. That name should therefore be avoided. "Premium efficiency" is a common descriptor in model names and marketing literature, but it has no official definition. It should therefore be avoided.

We advise caution in allowing use of an official logo for non-covered motors. Any motor model bearing the logo should be subjected to the same testing rigor as covered motors and clearly be equivalent to the enclosure and speed of covered motors. It is possible to produce a motor with good full load efficiency at the expense of part load efficiency and starting performance not being equal to that required of covered motors.

## K. Warning Label for Verifying Load Requirements

A discussion is presented on page 60454 regarding warning labels for verifying load requirements. As suggested, this would be to, "alert users to verify load requirements before installation, and to prevent possible misapplication and wasted energy." We strongly agree with the Department, that while care in motor application is important, this particular matter does not warrant a labeling requirement. The concern stems from the fact that the mean rated speed of an average energy efficient motor is very slightly (less than one percent) higher than the mean rated speed of an otherwise comparable standard efficiency alternative. Speed variation within an efficiency class is actually greater than the difference between mean speed of standard models versus energy efficiency models. Therefore if such a warning were applied, its presence should relate to the actual nameplate rpm rather than whether the motor meets EPCA efficiency standards. The best policy is to leave this matter to documents on motor application and not squeeze it onto the crowded motor nameplate.

## L. Laboratory Accreditation

We are concerned about a manufacturer's own laboratory sufficing as an "independent" laboratory. Apparently the Department shares this concern because a considerable amount of supporting material has been provided on this subject. We believe that there should be strong measures providing for disaccreditation if subsequent testing by outside laboratories finds overstating of efficiencies by a manufacturer's own laboratory.

## M. MotorMaster

Reference is made to the Washington State Energy Office's "MotorMaster" program on page 60462. That state agency was legislated out of existence in 1996. Responsibility for MotorMaster and the key personnel were relocated to the Washington State University Cooperative Extension Energy Program.

## N. Average

Section 431.2 defines "average full load efficiency" as the "average efficiency..." It would be more precise to call it the "arithmetic mean efficiency..." since "average" is sometimes loosely used to convey various measures of central tendencies such as median or mode.

## O. IEEE

This acronym is incorrectly given an extra "I", reading "IIEEE" in Section 431.2.

## P. Selecting basic models for testing

Section 431.24 provides that two of the basic models [for testing] must be among the five basic models with the highest unit volumes of production by the manufacturer in the prior year. The unit volume should be horsepower weighted; otherwise there will be a bias toward small motors which are invariably more numerous.

Q. Random selection of basic models for testing

Section 431.24 requires that within certain limiting criteria the manufacturer will select at random which basic models will be tested. We believe it would be best for the Department to retain the right of selecting those basic models. Similarly it is stated that for subsequent verification of an AEDM each manufacturer shall periodically select basic models for testing or verification. Likewise, we believe it would be best for the Department to retain the right to select which models will be tested or verified.